03 The Gaseous State

Set B **Exam practice**

Name	Time 1 hour	Total 36 marks	Score ____ / 36

Data: R = 8.31 J mol^{-1} K^{-1}, 1 atm = 101 325 Pa, L = 6.02 × 10^{23} mol^{-1}, A_r: H 1.0, C 12.0, N 14.0, O 16.0, Ar 39.9.

Marks by notes section For the marker: total each row. A score below the target means that section of the notes needs revising.

Notes section	Questions	Marks	Target	Score
2 The Gas Laws	6(c)	2	2	
3 The Ideal Gas Equation	2, 4(b), 7(a), 10(a)(ii), 10(c)	10	6	
4 Dalton's Law of Partial Pressures	1, 11	4	3	
5 Kinetic Theory of Gases	5(a)	3	2	
6 Real Gases	3, 4(a), 4(c), 5(b)(ii), 6(a), 6(b), 8, 9, 10(a)(i)	13	8	
2 Relative Masses of Atoms *(Topic 01)*	10(b)	1	1	
9 Intermolecular Forces *(Topic 02)*	5(b)(i)	2	2	
4 Stoichiometry, Limiting Reagent and Yield *(Topic 06)*	7(b)	1	1	

A Multiple choice

3 MARKS

1 A 5.0 dm^3 sample of oxygen at a pressure of 200 kPa and a 2.0 dm^3 sample of nitrogen at a pressure of 500 kPa are put into a 2.5 dm^3 vessel at constant temperature.

What is the total pressure in the vessel?

A 500 kPa **B** 700 kPa **C** 725 kPa **D** 800 kPa

Answer ☐ [1]

/1

Source: N01/3/6, via EJC 2022 JC1 Gaseous State Tutorial, B2

2 At 400 K, the following species behave as ideal gases: H_2, CH_4, NO_2, Ar. 5.00 g of each gas is put separately into a gas syringe kept at 400 K. The volume of each gas is adjusted to be the same, and the pressure is measured.

Which gas will have the lowest pressure?

A H_2 **B** CH_4 **C** NO_2 **D** Ar

Answer ☐ [1]

/1

Source: 2023 CJC J2 Prelim P1 Q7

3 COMMON Which gas would behave most like an ideal gas under room conditions?

A ammonia **B** helium **C** krypton **D** nitrogen

Answer ☐ [1]

/1

Source: 2023 YIJC J2 Prelim P1 Q2

B Structured questions

33 MARKS

4 **(a)** COMMON State two conditions under which real gases behave most ideally.

.....

[1]

(b) Calculate the volume, in dm^3, of 5.2 mol of an ideal gas at 101 300 Pa and 15 °C.

[1]

(c) 5.2 mol of ammonia gas under the same conditions as in (b) occupies 117 dm^3. Explain, in terms of the properties of ammonia molecules, why this volume is lower than that of an ideal gas.

.....

.....

[1]

/3

Source: 2023 RI J2 Prelim P3 Q2(a)

5 **(a)** COMMON State three ways in which an ideal gas differs from a real gas.

.....

.....

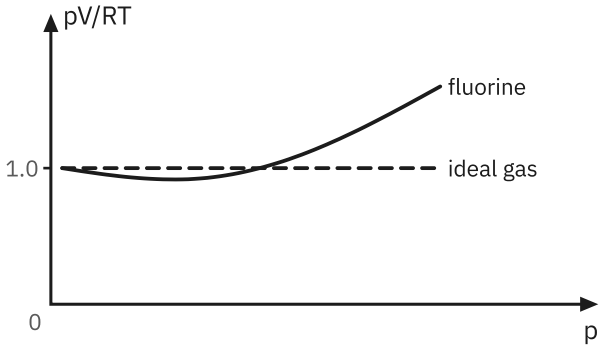
.....

[3]

(b) (i) Draw a labelled diagram to show the significant force of attraction between two molecules of hydrogen fluoride. Name the attraction in your diagram.

[2]

COMMON (ii) The graph shows pV/RT against p for 1 mol of an ideal gas and 1 mol of fluorine at 300 K. On the same axes, sketch pV/RT against p for 1 mol of hydrogen fluoride at 300 K. Explain your answer.



.....

.....

..... **[2]**

/7

Source: 2023 VJC J2 Prelim P2 Q1

6 NH_3 is used in space missions and in many chemical reactions.

(a) On the axes below, sketch a graph of pV/T against pressure, p, for 1 mol of an ideal gas.



[1]

(b) COMMON On the same axes, sketch and label the graph for 1 mol of NH_3. Explain the non-ideal behaviour of NH_3 at moderately high pressure.

.....

.....

..... **[2]**

(c) NH_3 is held in a 5.00 dm^3 flask at 27 °C and 4.00 atm. The gas is compressed at constant temperature to half its volume, then heated to 227 °C at constant volume. Assuming ideal behaviour, calculate the final pressure, in atm.

[2]

/5

Source: 2025 RI J2 Prelim P3 Q1(a)(ii) to (iv)

7 Indirect calorimetry estimates the energy a person uses from the difference in oxygen content between inhaled and exhaled air. In aerobic respiration at 37 °C, glucose is oxidised in reaction 1.

$$\text{reaction 1} \quad C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l) \quad \Delta H^{\ominus} = -2818 \text{ kJ mol}^{-1}$$

(a) Air contains about 21% oxygen by volume, and exhaled air contains 14%. At rest, an adult breathes about 500 cm^3 of air per breath, 12 times a minute, at 37 °C and 1 atm. Assuming oxygen is an ideal gas, calculate the volume of oxygen used per minute, and hence the amount of oxygen used per minute.

[3]

(b) Assuming all the oxygen used is consumed in reaction 1, calculate the energy released per minute.

[1]

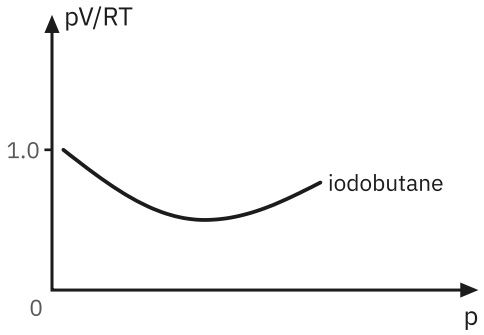
/4

Source: 2025 EJC J2 Prelim P3 Q1(a)(ii) and (iii)

8 COMMON The graph shows pV/RT against p for one mole of iodobutane gas at 200 °C.

compound	boiling point / °C
bromobutane	101
iodobutane	131

On the graph, show how one mole of bromobutane behaves at the same temperature.



[1]

/1

Source: 2025 DHS J2 Prelim P2 Q2(d)(ii)

9 COMMON Hydrazine, N_2H_4, is used as a rocket fuel. N_2H_4 does not behave as an ideal gas. State and explain two reasons for its deviation from ideal behaviour.

.....

.....

.....

.....

[2]

/2

Source: 2025 ACJC J2 Prelim P3 Q1(d)(iii)

10 Noble gases such as neon are used in discharge tubes ("neon" lights).

(a) COMMON (i) Give two reasons why the noble gases behave less ideally down the group from He to Xe.

.....

.....

.....

[2]

(ii) A mixture of krypton and xenon is obtained from air. At 300 K and 8.00×10^4 Pa, 1.00 dm^3 of the mixture has a mass of 2.79 g. Calculate the average M_r of the mixture.

[2]

(b) A sample of naturally occurring krypton has the isotopic composition below. Calculate the A_r of krypton.

nucleon number	80	82	83	84	86
relative abundance / %	2.4	11.7	11.6	56.9	17.4

[1]

(c) An evacuated 1.00 dm^3 glass bulb gains 3.40 g when it is filled with another sample of krypton at 293 K and 1.00 × 10^5 Pa. Calculate the A_r of this sample. Is its isotopic composition likely to be the same as in (b)? Explain your answer.

.....

.....

[3]

/8

Source: N95/1/3, modified, via EJC 2022 JC1 Gaseous State Tutorial, B3

11 CHALLENGE Xenon and fluorine are mixed in a 1 : 1 ratio by volume and sealed in a vessel at constant temperature. Crystals form on the walls, and the pressure falls to 70% of its starting value. The gases left contain 4 parts xenon to 3 parts fluorine. Deduce the equation for the reaction.

[3]

/3

Source: RJC 2010/11 Gaseous State Tutorial, Q5